The Operating Room Environment as Affected by People and the Surgical Face Mask

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The environment of the operating room has in the more recent literature been hypothesized as a source of surgical wound infections.[1, 2] Most of the microbiological data (Air Settle Plates, and volume sampling) be it impressive, has not as yet been correlated with wound infections.[3, 4] To understand the microbiological data more thoroughly, however, one must have baselines upon which further work and understanding may be achieved. This study was therefore, outlined to answer the following questions: (1) The levels of environmental contamination in operating rooms without personnel. (2) The levels of microbial contamination of operating room support areas such as hallways. (3) The effect the doors (closed, open or swinging) have upon the source of environmental contamination in the operating rooms. (4) The effect people dressed in scrub clothes but not gowned and gloved, have upon environmental contamination. (5)The effect the surgical face mask has upon the environmental contamination in the hallways, between the operating rooms and the operating rooms themselves.

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METHODS AND MATERIALS

PHASE I

An operating room suite consisting of 8 entirely similar rooms, located around a sealed off hallway was the source of all our data. Twenty 150 mm Air Settle Plates (ASP) containing trypticase soy agar were peripherally placed about the hallway and 6 placed in each operating room, all 4 feet from the floor (Fig. 1). In 4 operating rooms all the doors remained shut, in 2 the main door was left open and in 2 the main door was swung open and closed 50 times per hour. The Air Settle Plates in each room were put in place, opened and closed by one person. Ten people dressed in scrub pants and shirts, shoe covers and hoods, paced evenly throughout the hallway over a one hour period of time (this was considered a run). There were 4 runs during which all the personnel wore a fiberglass face mask and 4 runs in which they did not.

PHASE II

This study was conducted in an operating room equipped with a horizontal wall-less laminar air-flow system. The laminar air-flow system was turned on for 5 minutes to reduce airborne contamination present within the room prior to each study session. After this 5-minute period the unit was turned off and the conventional ventilating system was used. In the study session 5 subjects attired in scrub suits (scrub shirt and pants), shoe covers, and hoods, walked uniformly around the operating room for a period of 30 minutes. Twenty such sessions were studied, 10 with surgical face masks worn by all the individuals and 10 without the face masks. The face mask was the same type fiberglass mask as in the hallway experiment evaluation. Air samplings during the 30-minute sessions was accom-

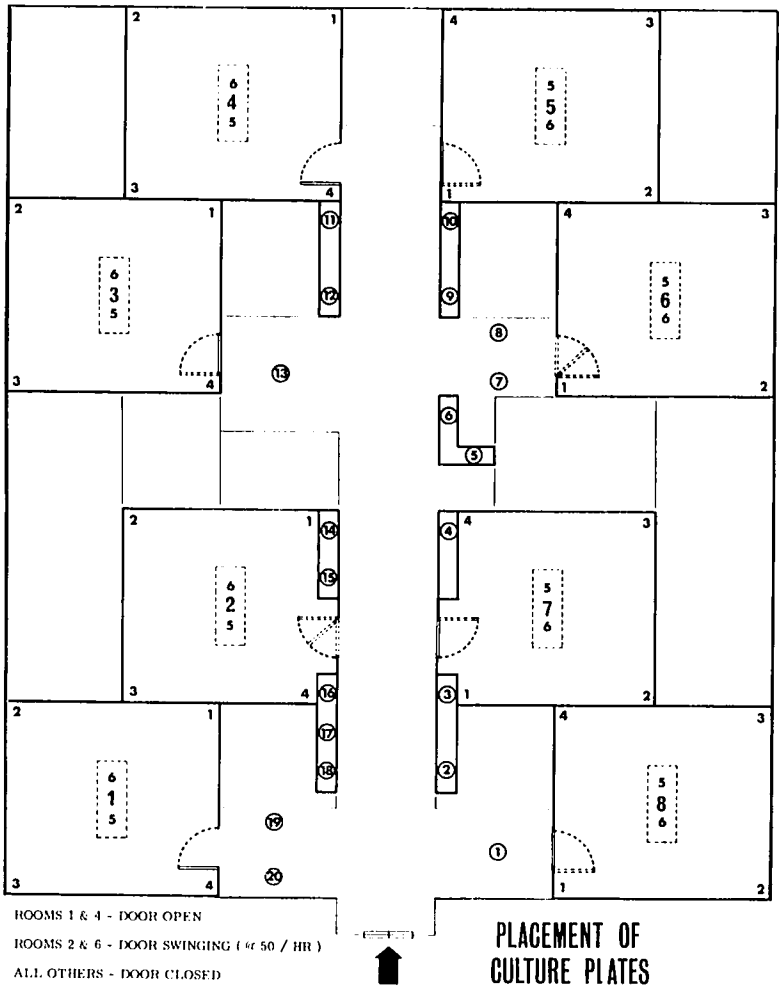

FIG. 1. An operating room suite with 8 operating rooms about a hallway. The numbers in each operating room and hallway represent where the ASP were placed.

plished by positioning eight ASP throughout the operating room 4 feet above the floor (wound high). One was placed upon each end of the operating table and 3 on each side of the table midway between the table and the periphery of the room.

All the Air Settle Plates for both phases were incubated at 37° for 24 hours and at room temperature for 6 days prior to counting of microbial colonies. All the counts were then standardized as to the number of colony forming units (CFU)/ft²/hr by the formula:

$$\text{CFU/ft}^2\text{/hr} = \frac{\text{ASP Count}}{\frac{.16499}{\text{time in minutes}}} \times 60 \text{ minutes}$$

RESULTS

PHASE I

The hallway results were broken down as to whether or not the Air Settle Plates were on open surfaces (184.3 ± 115.) or in open cabinets (157.6 ± 145.6). There was no statistical difference as determined by the Student *t*-test. The surgical face mask did not influence their counts (129.7 ± 115.2 with masks and 167.9 ± 169.7 without masks). The counts in the operating rooms whether the doors were open, closed, or swinging were not influenced by the wearing of a face mask (Table 1).

TABLE 1.*

Door	No Mask		Mask		t-test
	Mean	Stand Dev.	Mean	Stand. Dev.	
Closed	15.2	31.5	9.1	23	1.448
Open	17.6	23.6	33	78.8	1.311
Swinging	14.5	29.1	24	63	0.947

* The effect of people in the hallways (with or without face masks) on the count in the operating rooms when the main door was open, shut, or swung open and closed 50 times/hr.

As the mask did not influence the counts, all the Air Settle Plate data were put together. There was no statistical difference between swinging and open doors or closed and swinging doors but there was between open and closed doors ($P < 0.05$) (Table 2).

PHASE II

In 10 study sessions in which the 5 individuals wore face masks in the operating room, there was an average of 447.3 (± 186.6) CFU/ft²/hr. In the 10 session studies without the face masks, an average of 449.7 (± 183) CFU/ft²/hr were collected on 76 Air Settle Plates.

DISCUSSION

It is obvious from the above data that a major source of the environmental contamination in our study is people, since the closed operating rooms without people only had a mean count of 13.3 (± 30.9) CFU/ft²/hr. This jumped drastically to 447.3 (± 186.6) CFU/ft²/hr when masked individuals were in the room. This count, however, was no different than the count with people and no masks [449.7 (± 183) CFU/ft²/hr].

The effect the people in the hallway have upon the counts in the operating rooms is easy to understand when the doors remain open as well as the rooms where the doors are swung open and closed. One can see, however, from Table 2 the counts get progressively larger as the doors are left open (13.3 closed, 19.4 swinging and 24.8 open). The only statistical effect was when the doors were left open.

Airborne contamination in the optrating room as demonstrated by the Air Settle Plate counts was practically identical in the 10 sessions both when face masks were worn and when they were not worn. There is no statistical difference between the average counts with or without the face masks. We are convinced that the data demonstrate that face masks do not necessarily contain micro-organisms, but rather redirect their flow out the sides of the mask. The other conclusion one might consider

TABLE 2. The Comparison of the Number of CFU/ft²/hr in an Operating Room in Which the Main Door was Shut, Open or Swung Open and Closed 50 Times/hr

Door Activity	Mean	Stand Dev.	Door Activity	Mean	Stand Dev.	t-test
Swinging	19.4	49.7	Open	24.8	58.8	.858
Open	24.8	58.8	Closed	13.3	39.0	2.34*
Closed	13.3	30.9	Swing	19.4	49.7	1.02

* $P < 0.05$.

is that the environmental microbial contamination from the body and upper respiratory tract of operating room personnel is not significantly altered by the wearing of a surgical face mask. Therefore, we are of the opinion that the face mask need not be worn in the hallways between the operating rooms and in the operating rooms when a surgical case is not being performed; but, during surgery, it most definitely alters the projectile effect introduced by talking and breathing, thus its usefulness.

The answers to the proposed questions are therefore: (1) The environmental contamination in a conventional new empty operating room is minimal [13 CFU/ft²/hr (± 31)]. (2) The counts in the hallways differ from the operating rooms with people (168.1 ± 170 CFU/ft²/hr *vs* 447). This is probably related to a larger area of diffusion and fewer people in a concentrated area. (3) The only statistical effect the doors play upon the counts in the room is when they are left open allowing the environmental contamination from the hallway to pass freely into the room. (4) People seem to be a major influence upon the counts in an operating room (447.3 ± 186.7 CFU/ft²/hr, compared to 13 CFU/ft²/hr when the room is empty). (5) The surgical face mask contributes nothing to the effect upon the overall bacterial contamination in the operating suite environment.

SUMMARY

The microbiological counts were determined in an operating room suite of 8 rooms and a hallway. The bacterial counts in an empty operating room jumped statistically from 13 CFU/ft²/hr (± 31) to 24.8 (± 58.8) when the doors were left open (people in the hallways) and 447.3 (± 186.7) when 5 people were introduced. The wearing of a surgical face mask had no effect upon the overall operating room environmental contamination and probably work only to redirect the projectile effect of talking and breathing. People are the major source of environmental contamination in the operating room.

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